

**Sound Refining Mudflat Area
Focused Site Characterization Data Report**

Prepared for:

The Port of Tacoma
One Sitcum Plaza
Tacoma, WA 98424

Prepared by:

Anchor Environmental, L.L.C.
1411 4th Avenue, Suite 1210
Seattle, WA 98101

October 23, 2000

TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	REPORT ORGANIZATION	2
3	SEDIMENT SAMPLING EFFORT	3
3.1	SAMPLE COLLECTION.....	3
3.1.1	Surface Sediment Sample Collection.....	3
3.1.2	Subsurface Sediment Sample Collection	5
3.2	SAMPLE HANDLING.....	6
3.3	FIELD QUALITY ASSURANCE SAMPLES	7
3.3.1	Field Homogenization Duplicate Sample	7
3.3.2	Field Blank Sample.....	7
3.4	DEVIATIONS FROM THE SAMPLING PLAN	7
4	CHEMICAL/PHYSICAL ANALYSES	8
4.1	METHODS.....	8
4.2	DATA QUALITY ASSESSMENT	8
5	REFERENCES.....	9

LIST OF APPENDICES

Appendix A – Sediment Core Logs

Appendix B – Chemistry Data Validation Report

LIST OF FIGURES

Figure 1. Sound Refining Mudflat Area Sediment Sampling Locations

LIST OF TABLES

Table 1. Surface and Subsurface Locations and Depths

Table 2. Field Quality Assurance Sample Results

Table 3. Chemical/Physical Analysis Methods and Target Detection Limits

Table 4. Surface and Subsurface Chemistry Data

1 INTRODUCTION

Anchor Environmental, LLC (Anchor) conducted a limited environmental investigation for the Port of Tacoma (Port) of the existing mudflat/intertidal area west of the Sound Refining Site in Tacoma, Washington. The property is bounded by Sound Refining to the southeast, by 11th Street to the north, Airo Services and Marine Supply to the east, and Hylebos Waterway to the west. The exiting mudflat area (i.e., below elevation +11.8 ft MLLW shoreline, NOS datum) covers an area of approximately 19.6 acres. The focused mudflat characterization supplemented sediment data collected previously in this area by the Hylebos Cleanup Committee (HCC, 1999), and consisted of the collection of surface sediment and co-located subsurface sediment samples.

The sampling and analysis plan (SAP) for this project describes all procedures followed during the collection and analysis of sediment (Anchor and Port, 2000). All sample handling and chemical analyses were in accordance with the most recent Puget Sound Estuary Program (PSEP) protocols (PSEP 1986 as updated in 1989, 1991, 1995, and 1997). Marine Sampling Systems (MSS) provided the sampling platform, and along with Anchor staff, collected sediment cores during field activities. Anchor processed the sediment cores at the Rosa Environmental and Geotechnical Laboratory, LLC (REG) facility located in Seattle, Washington. Analytical Resources, Inc. (ARI), located in Seattle, Washington, conducted the chemical analyses for the sediment samples.

This document summarizes the procedures followed, identifies deviations from the SAP, and presents the sediment chemistry results.

2 REPORT ORGANIZATION

This report presents the results of the sampling and analysis program as described in the project SAP (Anchor and Port, 2000). This report is organized as follows:

- Section 1 – Introduction
- Section 2 – Report Organization
- Section 3 – Sediment Sampling Effort
- Section 4 – Chemical/Physical Analyses
- Section 5 –References

Figures and tables compiling and illustrating the data are presented at the end of this document.

Appendices provide supporting project documentation and are organized as follows:

- Appendix A –Sediment Core Logs
- Appendix B – Chemistry Data Validation Report

3 SEDIMENT SAMPLING EFFORT

This section summarizes the sampling strategy (Anchor and Port, 2000) for the Sound Refining Mudflat Area Focused Site Characterization. Sediment core logs are provided in Appendix A. Deviations from the SAP are also discussed in this section.

3.1 SAMPLE COLLECTION

Surface sediment samples were collected from eight locations within the Sound Refining intertidal area on July 14, 2000. Co-located subsurface sediments were collected from three of the surface sediment stations (Stations 4, 7, and 8) on July 13, 2000. Sampling locations are shown on Figure 1.

Anchor was responsible for field operations related to collecting, compositing, and transporting the sediment samples to the analytical laboratory for analysis. MSS assisted Anchor in the collection of the surface and subsurface sediment samples. MSS provided the sampling platform (*R/V Nancy Anne* and a small pontoon boat), the van Veen surface sediment sampler, the coring device (vibracorer), assisted in collecting the sediment surface grabs and cores, and operated the on-board differential global positioning system (DGPS). Station coordinates and mudline elevations for each surface and subsurface sample collected are provided in Table 1.

3.1.1 Surface Sediment Sample Collection

Surface sediment sampling was conducted using a small pontoon boat, which was operated under the direction of Bill Jaworski, owner of MSS, and coordinated by Anchor personnel. The pontoon boat is a 14-foot long, 10-foot wide platform with a small outboard motor, and a draft of 1-foot. The platform is equipped with a small hydraulic power supply, which operates the capstan and sampling gear. The platform is also equipped with an aluminum I-beam spud with foot assembly, which can be raised, lowered, or tilted.

The *R/V Nancy Anne* was used as the staging boat and was anchored just outside of the intertidal area. The *R/V Nancy Anne* is an aluminum, flat deck, 36-foot-long, 14-foot wide catamaran vessel with twin 120-horsepower engines, and a draft ranging from 18 inches forward to 24 inches aft. The *R/V Nancy Anne* is equipped with a 14-foot-high hydraulically operated A-frame with boom, a variable speed winch (3,000 pound capacity, 1 to 3 ft/sec), and 270 square feet of deck space. The vessel is also equipped with a pilot house, freshwater and seawater pumps, differential global positioning system (DGPS), and a depth sounder.

When possible (water levels are adequate), sampling was conducted off of the *Nancy Anne*. However, when water levels did not permit maneuvering of the *Nancy Anne* within the intertidal area, sampling was conducted off of the pontoon boat.

When possible, sampling coordinates were recorded using a DGPS unit with an accuracy of 3-feet or less, when signals were available. Otherwise, sampling coordinates were recorded using a hand held GPS unit and were documented on the site map in relation to land based structures and bathymetry. At the time of sampling, the geodetic horizontal position (i.e., latitude and longitude) of each sample location was documented to the nearest 0.01 seconds in NAD83, Washington State North Zone Datum. Mudline elevation was recorded at each sample location. Mudline elevations were determined by lead line measurements, local tide gages, and published

tide tables and referenced to the MLLW datum. Calculated mudline elevations at the sampling locations were rounded to the nearest 1.0-foot.

Surface sediment samples from the 0 to 10-cm biologically active zone were collected for chemical and physical testing using a van Veen grab sampler in accordance with Puget Sound Estuary Program (PSEP) protocols (PSEP 1997a). Samples were collected in the following manner in accordance with the PSEP protocols:

- Vessel was maneuvered to the proposed location;
- Jaw assembly was decontaminated;
- Jaw assembly was deployed;
- The cable to the jaw assembly was drawn in taut and perpendicular;
- Location of the cable hoist was measured and recorded by the location control personnel;
- The jaw assembly was drawn shut to collect the sediment sample to a penetration depth of approximately 16-cm for a 0 to 10-cm grab;
- The sediment sample was retrieved aboard the vessel and evaluated against the following PSEP acceptability criteria:
 - van Veen sampler is not overfilled (i.e., sediment surface against top of sampler);
 - Sediment surface is relatively flat, indicating minimal disturbance or winnowing;
 - Overlying water is present, indicating minimal leakage;
 - Overlying water has low turbidity, indicating minimal sample disturbance, and;
 - Desired penetration depth is achieved.
- Overlying water was siphoned off and a stainless steel trowel or similar device was used to collect only the desired sediment fraction from inside the van Veen sampler, taking care not to collect sediment in contact with the sides/surface of the sampler;
- The desired sediment fraction from the inside of the van Veen sampler was placed in a high-density polyethylene (HDPE) bucket. When sufficient sample volume was collected into the HDPE bucket, the sediment was homogenized using stainless steel spatulas or a variable speed drill fitted with a stainless steel paddle; and
- Homogenized sediment was placed immediately into appropriate pre-labeled sample containers and placed on ice for transport to the analytical laboratory.

To prevent sample contamination, all sampling equipment in contact with the sediment samples was decontaminated prior to and between collection activities. Decontamination procedures included rinsing with site water and washing with a scrub brush until free of sediment, wash with phosphate-free detergent, and triple-rinses with distilled water.

3.1.2 Subsurface Sediment Sample Collection

Sediment boring samples were collected from three selected stations using a vibracorer. The vibracorer unit consists of two contra-rotating electric motors encased in an aluminum housing. An electric generator on the vessel via a submersible tether cable powers the vibracorer. When energized, the motors produce a high-frequency vibration capable of penetrating most unconsolidated strata.

The vibracorer was deployed from the pontoon boat using the I-beam spud as a guide assembly for the core driving vibration head. A 3.75-in. inside diameter decontaminated aluminum pipe was cut to the appropriate length based on the sampling depth at each location and clamped to the vibracorer. The vibracorer was deployed to the bottom, where the unit was energized and lowered to the appropriate depth. When that depth was reached, the vibracorer was turned off and returned to the surface for sample processing. During the coring operation, the penetration of the core pipe was continuously monitored. The core was then capped and sent to the compositing site (REG laboratory located in Seattle, Washington).

The following procedure was used to decontaminate sample tubes prior to use:

- Rinse and pre-clean with potable water
- Wash and scrub the tubes in a solution of laboratory grade non-phosphate based soap and potable water
- Rinse with potable water
- Rinse three times with distilled water
- Seal both ends of each core tube with aluminum foil

The core tube caps were removed immediately prior to placement into the coring device. Care was taken during sampling to avoid contact of the sample tube with potentially contaminated surfaces. Extra sample tubes were available during sample operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated were not used. Logs and field notes of all core samples were maintained as samples were collected and correlated to the sampling location map. The following information was included in this log:

1. Elevation of each boring station sampled as measured from NOS MLLW. This was accomplished using a fathometer or lead line to determine the depth of water at the time of sampling. The elevation was converted to NOS MLLW using tide data obtained from the Commencement Bay NOAA gaging station.
2. Location of each boring station as determined by DGPS.
3. Date and time of collection of each sediment core sample.
4. Names of field supervisor and person(s) collecting and logging the sample.
5. Observations made during sample collection included weather conditions, complications, ship traffic, and other details associated with the sampling effort.
6. The sample station number as derived from Figure 1.
7. Length and depth intervals of each core section and recovery for each sediment sample as measured from NOS MLLW.

8. Qualitative notation of apparent resistance of sediment column to coring.
9. Any deviation from the sampling plan.

During deployment and retrieval of the coring device, care was taken to ensure that the end of the core tube did not become contaminated. When retrieved, each core was inspected and a physical description of the material at the mouth of the core was entered into the core log.

Core tubes longer than 4 feet were cut in half to facilitate upright storage. The cut tubes were individually labeled. Core orientation was also marked on each tube. Labels identifying the core section were securely attached to the outside of the casing and wrapped with transparent tape to prevent loss or damage of the label. The core sections were stored upright in iced containers for transport to the core processing facility.

At the core processing facility, the cores were cut open and a sediment description of each core sample was recorded on the core log. Sample intervals were selected from the cores collected based on physical observations such as presence of oil, woody debris, and/or odor. After documenting the core, the sediment from each interval was placed in a stainless steel bowl or HDPE bucket, and was homogenized using a stainless steel spoon or variable speed drill fitted with a stainless steel paddle. Homogenized sediment was then placed into the appropriate sample jars as indicated in Table 1 of the SAP (Anchor and Port 2000).

3.2 SAMPLE HANDLING

The analytical lab provided certified, pre-cleaned, EPA-approved containers for all samples. Prior to shipping, the analytical laboratory added preservative, where required, according to PSEP protocols.

All containerized sediment samples were transported to the analytical laboratory after preparation was completed. Specific sample shipping procedures were as follows:

1. Individual sample containers were placed in a sealable plastic bag, packed to prevent breakage and transported in a sealed ice chest or other suitable container.
2. The shipping containers were clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container and consultant's office name and address) to enable positive identification.
3. Glass jars were separated in the shipping container by shock absorbent material (e.g., bubble wrap) to prevent breakage.
4. A sufficient amount of ice was double-bagged in sealable plastic bags and placed within the cooler.
5. A sealed envelope containing chain-of-custody forms was enclosed in a plastic bag and taped to the inside lid of the cooler.
6. Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping.
7. Samples were delivered to the analytical laboratory within 24 hours of collection.

The persons transferring custody of the sample container signed the chain-of-custody form upon transfer of sample possession to the analytical laboratory. The shipping container seal was

broken upon receipt of samples at the laboratory and the receiver recorded the condition of the samples. Chain-of-custody forms were used internally by the lab to track sample handling and final disposition.

All samples were maintained according to the appropriate holding times and temperatures for each analysis as represented in Table 1 of the SAP (Anchor and Port 2000).

3.3 FIELD QUALITY ASSURANCE SAMPLES

Field quality assurance (QA) samples were collected to assess potential problems as a result of sample collection and/or processing in the field. One field homogenization duplicate and one field equipment rinsate blank were submitted as discrete blind samples to the laboratory for analysis. The field homogenization duplicate was analyzed for all parameters, whereas the rinsate blank was analyzed for metals and organic compounds only. The field QA sample results corroborated the accuracy and precision of chemical determinations performed during this investigation.

3.3.1 Field Homogenization Duplicate Sample

One field homogenization duplicate sample was collected at Station AN-6 and submitted to the laboratory as a discrete blind sample. The field homogenization duplicate consists of a split from a homogenized sample. The purpose of obtaining and analyzing the field homogenization duplicate was to assess the sample handling and field homogenization techniques. In general, field replicate results are considered acceptable if they are within an order of magnitude of one another. Relative percent difference values for the field duplicate ranged from 0 to 40 percent, with the exception of total petroleum hydrocarbons (TPH), indicating that the sediment handling and homogenization techniques did not impact the quality of analytical results obtained for this investigation. The relative percent differences for the TPHs was elevated due to the relatively small amount present in the sample.

3.3.2 Field Blank Sample

One equipment rinsate blank was submitted to the laboratory as a discrete blind sample. The rinsate blank was collected immediately following equipment decontamination prior to initiating collection of surface sediments. The rinsate blank was prepared by pouring distilled water over the decontaminated sampling and compositing equipment into a pre-preserved sample jar. The purpose of the equipment rinsate blank was to assess the degree to which a parameter of interest was added or removed during field operations such as equipment decontamination. No compounds or analytes were detected in the equipment rinsate blank (See Table 2).

3.4 DEVIATIONS FROM THE SAMPLING PLAN

The field equipment rinsate blank was collected immediately prior to surface sediment sample collection rather than during the sample collection activities. However, since all sediment concentrations were consistently low (Table 4), potential sample cross contamination is considered unlikely.

4 CHEMICAL/PHYSICAL ANALYSES

Surface sediment samples were analyzed for selected analytes/compounds, including all State Sediment Management Standards (SMS; Chapter 173-204 WAC) parameters and selected conventionals (grain size, total solids, TOC, and TPH). Selected subsurface sediment samples were submitted for chemical testing based on physical observations (e.g., presence of woody debris). The chemistry data are provided in Table 4.

4.1 METHODS

All sediment samples were analyzed in accordance with the methods outlined in Table 3.

4.2 DATA QUALITY ASSESSMENT

The overall data quality objectives for collection and chemical testing of sediment samples were met, as set forth in the SAP, with the exception of all antimony results. Matrix interferences were associated with the antimony analyses and due to the low recoveries of the matrix spikes all antimony results were rejected. All other data for this project are considered acceptable for use as qualified. Target detection limit goals were not met for 2,4 dimethylphenol and benzyl alcohol due to matrix interferences. The data validation report is presented in Appendix B of this report.

Validated chemical data are presented in Table 4.

5 REFERENCES

Anchor and Port. 2000. Sampling and Analysis Plan: Mudflat Area Focused Site Characterization, Hylebos Waterway, Tacoma, Washington. July 11, 2000

Hylebos Cleanup Committee, 1999. Pre-Remedial Design Evaluation Report, Hylebos Waterway Pre-Remedial Design Program, Commencement Bay Nearshore / Tideflats Superfund Site. Report prepared for U.S. Environmental Protection Agency. November 1999.

PSEP. 1986 as updated in 1989, 1991, 1995, and 1997. Recommended protocols for measuring selected environmental variables in Puget Sound. Prepared for the Puget Sound Estuary Program, U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

Table 1. Surface and Subsurface Locations and Depths

Station	Sample Type	Geographic Coordinates (NAD83) deg min sec		Mudline Elevation MLLW (ft)
		Latitude	Longitude	
1	Surface	47deg 16.6624 N	122deg 23.5138 W	1.5
2	Surface	47deg 16.7321 N	122deg 23.4575 W	5.5
3	Surface	47deg 16.6600 N	122deg 23.4332 W	0.5
4	Surface	47deg 16.7196 N	122deg 23.4339 W	5.4
4	Subsurface	47deg 16.7177 N	122deg 23.4297 W	5.3
5	Surface	47deg 16.6240 N	122deg 23.3423 W	3.7
6	Surface	47deg 16.679 N	122deg 23.286 W	7.1
7	Surface	47deg 16.6156 N	122deg 23.2660 W	3.0
7	Subsurface	47deg 16.6078 N	122deg 23.254 W	3.9
8	Surface	47deg 16.713 N	122deg 23.330 W	5.5
8	Subsurface	47deg 16.7111 N	122deg 23.3295 W	not recorded

Table 2. Field Quality Assurance Sample Results.

Parameter	AN-6-S (0-0.3 ft)	AN-6dup-S (0-0.3 ft)	Percent Difference	Equipment Rinsate Blank (ug/L)
Conventional Parameters				
Total solids (%)	35.2	34.7	1.4	
Gravel (%)	11.2	10.7	4.6	
Sand (%)	11.7	11.2	4.4	
Silt (%)	55.1	56.4	2.3	
Clay	22.0	21.7	1.4	
Total organic carbon (%)	3.7 E	4.6 E	21.7	
Total Petroleum Hydrocarbons				
Gas Range	30 U	20 U	40.0	
Diesel Range	50 U	130 E	88.9	
Oil Range	100 U	210 E	71.0	
Metals (mg/kg)				
Antimony	10 R	10 R	0.0	0.05 U
Arsenic	40.0	40	0.0	0.05 U
Cadmium	0.70	0.60	15.4	0.002 U
Chromium	37	39	5.3	0.005 U
Copper	86	85	0.2	0.002 U
Lead	89	90	1.1	0.02 U
Mercury	0.30	0.30	0.0	0.0001 U
Nickel	27	29	7.1	0.01 U
Silver	0.90 U	0.80 U	11.8	0.003 U
Zinc	232	236	1.7	0.006 U
Polycyclic Aromatic Hydrocarbons (ug/kg)				
Acenaphthylene	52	43	18.9	1.0 U
Acenaphthene	40	34	16.2	1.0 U
Acenaphthene	22 M	19 U	14.6	1.0 U
Fluorene	35	28	22.2	1.0 U
Phenanthrene	280	200	33.3	1.0 U
Anthracene	100	78	24.7	1.0 U
2-Methylnaphthalene	24	20	18.2	1.0 U
Fluoranthene	660	660	0.0	1.0 U
Pyrene	960	800	18.2	1.0 U
Benz(a)anthracene	250	210	17.4	1.0 U
Chrysene	590	530	10.7	1.0 U
Benzo(b)fluoranthene	670	640	4.6	1.0 U
Benzo(k)fluoranthene	400	370	7.8	1.0 U
Benzo(a)fluoranthene (b+k)	1,070	1,010	5.8	1.0 U
Benzo(a)pyrene	260	220	16.7	1.0 U
Indeno(1,2,3-c,d)pyrene	120	100	18.2	1.0 U
Dibenz(a,h)anthracene	35 M	29 M	18.8	1.0 U
Benzo(g,h,i)perylene	110	93	16.7	1.0 U
Chlorinated Hydrocarbons (ug/kg)				
1,2-Dichlorobenzene	2.3 U	2.5 U	8.3	1.0 U
1,3-Dichlorobenzene	2.3 U	2.5 U	8.3	1.0 U
1,4-Dichlorobenzene	2.3 U	2.5 U	8.3	1.0 U
1,2,4-Trichlorobenzene	12 U	13 U	8.0	5.0 U
Hexachlorobenzene (HCB)	3	NA	NA	1.0 U
Phthalates (ug/kg)				
Diethyl phthalate	20 U	19 U	5.1	1.0 U
Diethyl phthalate	20 U	19 U	5.1	1.0 U

Chemical	AN-6-S (0-0.3 ft)	AN-6dup-S (0-0.3 ft)	Percent Difference	Equipment Rinsate Blank (ug/L)
Di-n-butyl phthalate	20 U	23 M	14.0	1.0 U
Benzyl phthalate	220	230	4.4	1.0 U
Diethylhexyl phthalate	320	330	3.1	1.0 U
Di-n-octyl phthalate	54	36 M	40.0	1.0 U
Phenols (ug/kg)				
Phenol	39 U	39 U	0.0	2.0 U
2-Methylphenol	39 U	39 U	0.0	2.0 U
4-Methylphenol	20 U	19 U	5.1	1.0 U
2,4-Dimethylphenol	59 U	58 U	1.7	3.0 U
Pentachlorophenol	99 U	97 U	2.0	5.0 U
Miscellaneous Extractables (ug/kg)				
Benzyl alcohol	99 U	97 U	2.0	5.0 U
Benzoic acid	200 U	190 U	5.1	10.0 U
Dibenzofuran	27 M	23 M	16.0	1.0 U
Hexachloroethane	39 U	39 U	0.0	2.0 U
Hexachlorobutadiene	1 U	NA	N/A	2.0 U
N-Nitrosodiphenylamine	20 U	19 U	5.1	2.0 U
Volatile Organics (ug/kg)				
Trichloroethene	2.3 U	2.5 U	8.3	1.0 U
Tetrachloroethene	2.3 U	2.5 U	8.3	1.0 U
Ethylbenzene	2.3 U	2.5 U	8.3	1.0 U
m,p-Xylene	2.3 U	2.5 U	8.3	1.0 U
o-Xylene	2.3 U	2.5 U	8.3	1.0 U
Total Xylene (sum of o-, m-, p-)				1.0 U
Pesticides (ug/kg)				
DDT	6.4	6.2	3.2	0.10 U
DDT	2.9 Y	3.0 Y	3.4	0.10 U
DDT	2.0 U	1.9 U	5.1	0.10 U
Aldrin	0.99 U	0.94 U	5.2	0.05 U
alpha-Chlordane	1.6	1.5	6.5	0.05 U
gamma-Chlordane	1.1 Y	0.95 Y	14.6	0.05 U
Dieldrin	2.1 Y	2.0 Y	4.9	0.10 U
Heptachlor	0.99 U	0.94 U	5.2	0.05 U
gamma-BHC (Lindane)	0.99 U	0.94 U	5.2	0.05 U
PCBs (ug/kg)				
Aroclor 1016	20 U	19 U	5.1	1.0 U
Aroclor 1242	43 Y	38 Y	12.3	1.0 U
Aroclor 1248	20 U	19 U	5.1	1.0 U
Aroclor 1254	96	89	7.6	1.0 U
Aroclor 1260	59	60	1.7	1.0 U
Aroclor 1221	39 U	37 U	5.3	2.0 U
Aroclor 1232	20 U	19 U	5.1	1.0 U
Total PCBs (ug/kg)	155	149	3.9	2.0 U
Total PCBs (mg/kg-oc)				

Table 3. Chemical/Physical Analysis Methods and Target Detection Limits

Parameter	Target Detection Limits	Sample Preparation Method	Sample Cleanup Method	Analytical Method
Sediments and Native Material				
Conventional				
Percent solids in %	NA	---	---	EPA 160.3
Total petroleum hydrocarbons	25 mg/kg	EPA 3550	---	NWTPH-HCLD
Grain size in %	0.10%	---	---	PSEP
Total organic carbon in %	0.015%	---	---	Plumb (1981) or PSEP
Metals				
Arsenic	10 mg/kg dry	EPA 3050	---	EPA 6010
Cadmium	0.40 mg/kg dry	EPA 3050	---	EPA 6010
Chromium	1.0 mg/kg dry	EPA 3050	---	EPA 6010
Copper	0.40 mg/kg dry	EPA 3050	---	EPA 6010
Lead	5.0 mg/kg dry	EPA 3050	---	EPA 6010
Mercury	0.10 mg/kg dry	---	---	EPA 7471
Silver	0.60 mg/kg dry	EPA 3050	---	EPA 6010
Zinc	0.80 mg/kg dry	EPA 3050	---	EPA 6010
Low Molecular Weight Polynuclear Aromatic Hydrocarbons (LPAHs)				
Naphthalene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Acenaphthylene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Acenaphthene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Fluorene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Phenanthrene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Anthracene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
2-Methylnaphthalene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Total LPAHs		EPA 3545	EPA 3640	EPA 8270
High Molecular Weight Polynuclear Aromatic Hydrocarbons (HPAHs)				
Fluoranthene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Pyrene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Benzo(a)anthracene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Chrysene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Total benzofluoranthenes	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Benzo(a)pyrene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Indeno(1,2,3-cd)pyrene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Dibenzo(a,h)anthracene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Benzo(g,h,i)perylene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Total HPAHs		EPA 3545	EPA 3640	EPA 8270
Phthalates				
Dimethyl phthalate	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Diethyl phthalate	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Di-n-Butyl phthalate	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Butyl benzyl phthalate	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Bis(2-ethylhexyl)phthalate	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Di-n-Octyl phthalate	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Polychlorinated Biphenyls (PCBs)				
Total PCBs	8 ug/kg	EPA 3545	EPA 3640 and EPA 3665	EPA 8081
Volatile Organics				
1,2-Dichlorobenzene	5 ug/kg	EPA 5035	---	EPA 8260
1,4-Dichlorobenzene	5 ug/kg	EPA 5035	---	EPA 8260
1,2,4-Trichlorobenzene	10 ug/kg	EPA 5035	---	EPA 8260
Miscellaneous Semivolatile Organics				
Hexachlorobenzene	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Dibenzofuran	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Hexachlorobutadiene	30 ug/kg	EPA 3545	EPA 3640	EPA 8270
N-Nitroso-diphenylamine	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Miscellaneous Extractables				
Phenol	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
2-Methylphenol	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
4-Methylphenol	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
2,4-Dimethylphenol	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Pentachlorophenol	50 ug/kg	EPA 3545	EPA 3640	EPA 8270
Benzyl alcohol	20 ug/kg	EPA 3545	EPA 3640	EPA 8270
Benzic acid	200 ug/kg	EPA 3545	EPA 3640	EPA 8270

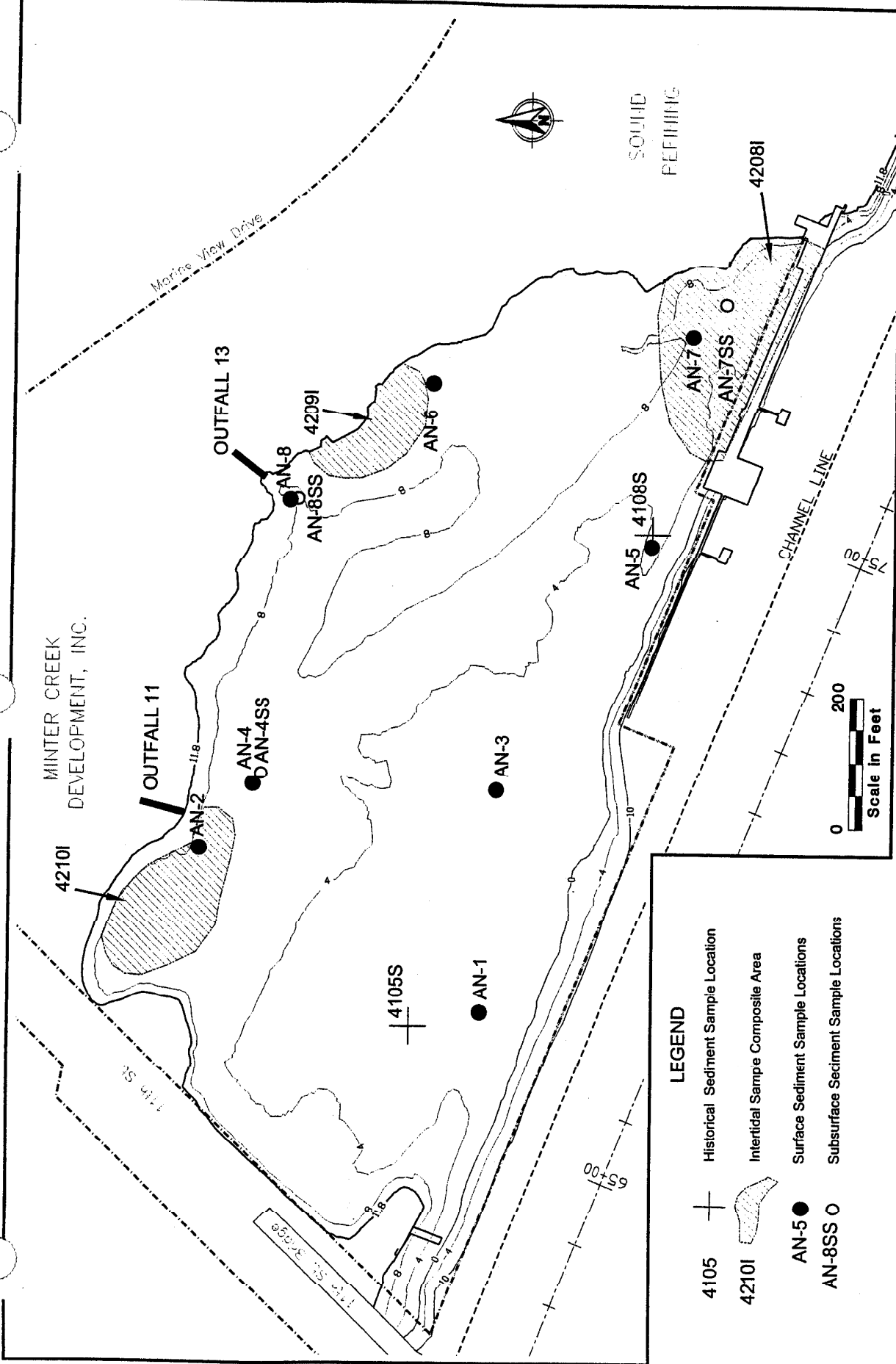
Notes:

(a) The sample digestion method for mercury is described in the analytical method.

Table 4. Surface and Subsurface Chemistry Data - Dry Weight Measurements

Chemical	AN-1-S (0-0.3 ft)	AN-2-S (0-0.3 ft)	AN-3-S (0-0.3 ft)	AN-4-S (0-0.3 ft)	AN-4A-C (1) (1-2-2.8 ft)	AN-4C-C (1) (3.8-4.8 ft)	AN-5-S (0-0.3 ft)	AN-6-S (0-0.3 ft)	AN-6dup-S (1-0.3 ft)	AN-7-S (0-0.3 ft)	AN-8-S (0-0.3 ft)	AN-9A-C (1) (0.8-1.8 ft)	Equipment Rinsete Blank (ug/L)
Conventional Parameters													
Total solids (%)	69.8	57.5	63.5	54.2	78.8	78.1	60.9	35.2	34.7	44.1	54.5	64.3	
Gravel (%)	10.5	10.1	4.3	3.3			0.70	11.2	10.7	20.4	11.6		
Sand (%)	81.2	41.3	75.1	29.8			69.0	11.7	16.9	36.5	57.7		
Silt (%)	4.6	34.5	15.6	48.8			20.3	55.1	56.4	22.1			
Clay	3.7	14.1	5.0	18.1			10.0	22.0	21.7	24.2	8.6		
Total organic carbon (%)	1.6 E	5.7 E	3.3 E	7.1 E	1.6	0.73	3.6 E	3.7 E	4.6 E	3.4 E	3.5 E	0.52	
Total Petroleum Hydrocarbons													
Gas Range	20 U	20 U	20 U	20 U			20 U	30 U	20 U	26 U	20 U		
Diesel Range	50 U	50 U	50 U	140	14	6.5 U	50 U	50 U	130 E	50 U	60	7.6 U	
Oil Range	100 U	100 U	100 U	260	24	13 U	100 U	100 U	210 E	100 U	190	15	
Metals (mg/kg)													
Antimony	7.0 R	8.0 R	7.0 R	9.0 R	6.0 U	6.0 U	8.0 R	10 R	10 R	10 R	9.0 R	8.0 U	0.05 U
Arsenic	7.0 U	23.0	10	24	6.0 U	6.0 U	19	40.0	40	10	9.0 U	8.0 U	0.05 U
Cadmium	0.30 U	0.60	0.30 U	0.70	0.20 U	0.30 U	0.30 U	0.70	0.60	0.50 U	0.30 U	0.30 U	0.002 U
Chromium	14	27	17	29	14	16	17	37	39	18	24	19	0.005 U
Copper	21	44	27	59	20	17	50	86	85	36	34	35	0.002 U
Lead	10	40.0	14	47	5.0	3.0	28	89	90	16	48	5.0	0.02 U
Mercury	0.060 U	0.15	0.060 U	0.16	0.05 U	0.06 U	0.070	0.30	0.30	0.080 U	0.070 U	0.06 U	0.0001 U
Nickel	10	23	13	22	10	11	11	27	29	14	19	15	0.01 U
Silver	0.40 U	0.50 U	0.40 U	0.50 U	0.40 U	0.40 U	0.50 U	0.90 U	0.80 U	0.70 U	0.50 U	0.50 U	0.003 U
Zinc	40	143	55	137	27	24	83	232	236	47	127	35	0.003 U
Organics (ug/kg)													
Total PAHs	612	3,117	1,132	3,464	489	20 U	4,763	4,608	4,055	640	1,449	19 U	
Total LPAH	40	393	114	450	217	20 U	642	529 M	383	32	103	19 U	
Naphthalene	20 U	49	25	57	84	20 U	32	52	43	19 U	19 U	19 U	1.0 U
Acenaphthylene	20 U	29	19 U	35	23	20 U	35	40	34	19 U	19 U	19 U	1.0 U
Acenaphthene	20 U	31	19 U	45	20 U	20 U	24	22 M	19 U	19 U	19 U	19 U	1.0 U
Fluorene	20 U	32	19 U	40	22	20 U	31	35	28	19 U	19 U	19 U	1.0 U
Phenanthrene	40	170	60	180	88	20 U	400	280	200	32	78	19 U	1.0 U
Anthracene	20 U	82	29	93	20 U	20 U	120	100	78	19 U	25	19 U	1.0 U
2-Methylnaphthalene	20 U	20	19 U	19 U	23	20 U	19 U	24	20	19 U	19 U	19 U	1.0 U
Total HPAH	572	2,704 M	1,018	3,014 M	272	20 U	4,121 M	4,055 M	3,652 M	608 M	1,346	19 U	1.0 U
Fluoranthene	110	530	190	560	110	20 U	660	660	680	91	230	19 U	1.0 U
Pyrene	120	650	210	800	110	20 U	1,000	960	890	120	300	19 U	1.0 U
Benz(a)anthracene	40	150	62	180	24	20 U	320	250	210	43	77	19 U	1.0 U
Chrysene	75	340	150	400	28	20 U	560	590	530	110	200	19 U	1.0 U
Benzofluoranthene	73	400	180	300	20 U	20 U	500	670	640	98	230	19 U	1.0 U
Benzokjfluoranthene	54	260	100	430	20 U	20 U	500	400	370	77	140	19 U	1.0 U
Benzofluoranthenes (b+k)	127	660	280	730	20 U	20 U	1,000	1,070	1,010	175	370	19 U	1.0 U
Benz(a)pyrene	40	160	65	190	20 U	20 U	340	260	220	48	86	19 U	1.0 U
Indeno(1,2,3-c,d)pyrene	31	91	31	71	20 U	20 U	110	120	100	21 M	40	19 U	1.0 U
Dibenz(a,h)anthracene	20 U	31 M	19 U	21 M	20 U	20 U	37 M	35 M	28 M	19 U	19 U	19 U	1.0 U
Benzofluoranthene	29	92	30	62	20 U	20 U	94	110	83	19 U	43	19 U	1.0 U
Chlorinated Hydrocarbons (ug/kg)													
2,2-Dichlorotoluene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
1,3-Dichlorobenzene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
1,4-Dichlorobenzene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
1,2,4-Trichlorobenzene	6.1 U	7.6 U	11 U	7.8 U			7.6 U	12 U	13 U	11 U	8.9 U		5.0 U
Hexachlorobenzene (HCB)	1 U	2	1	3	1 U	1 U	2 U	3	NA	1 U	1 U		1.0 U
Phthalates (ug/kg)													
Dimethyl phthalate	20 U	20 U	19 U	19 U	20 U	20 U	19 U	20 U	19 U	19 U	19 U	19 U	1.0 U

Chemical	AN-1-S (0-0.3 ft)	AN-2-S (0-0.3 ft)	AN-3-S (0-0.3 ft)	AN-4-S (0-0.3 ft)	AN-4A-C (1.8-2.8 ft)	14C-C (1) (3.8-4.8 ft)	AN-5-S (0-0.3 ft)	AN-6-S (0-0.3 ft)	AN-6dup-S (0-0.3 ft)	AN-7-S (0-0.3 ft)	AN-8-S (0-0.3 ft)	°C (1) (0.8-1.8 ft)	Equipment Rinsate Blank (µg/L)
Diethyl phthalate	20 U	20 U	19 U	19 U	20 U	20 U	19 U	20 U	19 U	19 U	19 U	19 U	1.0 U
Di-n-butyl phthalate	20 U	59	19 U	19 U	20 U	29	19 U	20 U	23 M	19 U	19	18 U	1.0 U
Butyl benzyl phthalate	20 U	120	19 U	80	20 U	20 U	41	220	230	23	100	19 U	1.0 U
Bis(2-ethylhexyl) phthalate	58	8,900	140	230	20 U	20 U	210	320	330	61	880	19 U	1.0 U
Di-n-octyl phthalate	20 U	5,200	19 U	24 M	20 U	20 U	21 M	54	36 M	20 M	270	19 U	1.0 U
Phenols (ug/kg)													
Phenol	40 U	39 U	160	39 U	20 U	20 U	54	39 U	39 U	44	55	19 U	2.0 U
2-Methylphenol	40 U	39 U	38 U	39 U	20 U	20 U	39 U	39 U	39 U	39 U	39 U	19 U	2.0 U
4-Methylphenol	20 U	96	58 M	120	20 U	20 U	25 M	20 U	19 U	24 M	19 U	19 U	2.0 U
2,4-Dimethylphenol	60 U	59 U	57 U	58 U	20 U	20 U	58 U	59 U	58 U	58 U	58 U	19 U	1.0 U
Pentachlorophenol	100 U	98 U	95 U	97 U	98 U	100 U	97 U	99 U	97 U	97 U	96 U	95 U	3.0 U
Miscellaneous Extractables (ug/kg)													5.0 U
Benzyl alcohol	100 U	98 U	95 U	97 U	20 U	20 U	97 U	99 U	97 U	97 U	96 U	19 U	50 U
Benzoic acid	200 U	200 U	190 U	190 U	200 U	200 U	190 U	200 U	190 U	190 U	190 U	190 U	100 U
Dibenzofuran	20 U	23	19 U	29	20 U	20 U	19 U	23 M	23 M	19 U	19 U	19 U	10 U
Hexachlorocyclopentadiene	40 U	39 U	38 U	39 U	20 U	20 U	39 U	39 U	39 U	39 U	39 U	19 U	20 U
N-Nitrosodiphenylamine	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U	20 U
Volatiles Organics (ug/kg)	20 U	20 U	19 U	19 U	20 U	20 U	19 U	20 U	19 U	19 U	19 U	19 U	20 U
Trichloroethene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
Tetrachloroethene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
Ethylbenzene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
m,p-Xylene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
o-Xylene	1.2 U	1.5 U	2.2 U	1.6 U			1.5 U	2.3 U	2.5 U	2.3 U	1.8 U		1.0 U
Total Xylene (sum of o-, m-, p-)													1.0 U
Pesticides (ug/kg)													1.0 U
DDE	1.9 U	4.7	1.9 U	5.4	1.8 U	1.9 U	3.9	6.4	6.2	1.9 U	2.0	1.9 U	0.10 U
DDD	1.9 U	3.4	1.9 U	4.6 Y	1.8 U	1.9 U	2.1 Y	2.9 Y	3.0 Y	1.9 U	1.8 U	1.9 U	0.10 U
DDT	1.9 U	2.0 U	1.9 U	2.2 Y	1.8 U	1.9 U	1.8 U	2.0 U	1.9 U	1.9 U	1.8 U	1.9 U	0.10 U
Aldrin	0.93 U	0.98 U	0.94 U	0.97 U	0.91 U	0.93 U	0.91 U	0.99 U	0.94 U	0.94 U	0.92 U	0.95 U	0.05 U
alpha-Chlordane	0.93 U	1.3	0.94 U	2.1	0.91 U	0.93 U	0.91 U	1.6	1.5	0.94 U	3.3 Y	0.95 U	0.05 U
gamma-Chlordane	0.93 U	0.98 U	0.94 U	1.2 Y	0.91 U	0.93 U	0.91 U	1.1 Y	0.95 Y	0.94 U	4.0	0.95 U	0.05 U
Dieldrin	1.9 U	2.0 U	1.9 U	2.2 Y	1.8 U	1.9 U	1.8	2.1 Y	2.0 Y	1.9 U	1.8 U	1.9 U	0.10 U
Heptachlor	0.93 U	0.98 U	0.94 U	0.97 U	0.91 U	0.93 U	0.91 U	0.99 U	0.94 U	0.94 U	1.0 Y	0.95 U	0.05 U
gamma-BHC (Lindane)	0.93 U	0.98 U	0.94 U	0.97 U	0.91 U	0.93 U	1.2 Y	0.99 U	0.94 U	0.94 U	0.92 U	0.95 U	0.05 U
PCBs (ug/kg)													
Aroclor 1016	19 U	20 U	19 U	19 U	18 U	19 U	18 U	20 U	19 U	19 U	18 U	19 U	1.0 U
Aroclor 1242	19 U	31 Y	21 Y	33 Y	18 U	19 U	25 Y	43 Y	38 Y	19 U	18 U	19 U	1.0 U
Aroclor 1248	19 U	20 U	19 U	19 U	18 U	19 U	18 U	20 U	19 U	19 U	18 U	20	1.0 U
Aroclor 1254	19 U	68	35	77	18 U	19 U	47	96	69	24	24	19 U	1.0 U
Aroclor 1260	13 U	54	19 U	61	18 U	19 U	47	59	60	16 J	19	19 U	1.0 U
Aroclor 1221	37 U	39 U	38 U	39 U	36 U	37 U	37 U	39 U	37 U	38 U	37 U	38 U	2.0 U
Aroclor 1232	19 U	20 U	19 U	19 U	18 U	19 U	18 U	20 U	19 U	19 U	17 U	19 U	1.0 U
Total PCBs	13 U	122	54 J	138	36 U	37 U	94	155	140	40	43	20	



Note:

1. Basemap provided by the Port of Tacoma.
2. All vertical elevations are related to MLLW (NDS).
3. Elevations/contours interpolated from Port base map contours derived from aerial photogrammetric mapping.

FIGURE 1
SOUND REFINING MUDFLAT AREA
SEDIMENT SAMPLING LOCATIONS